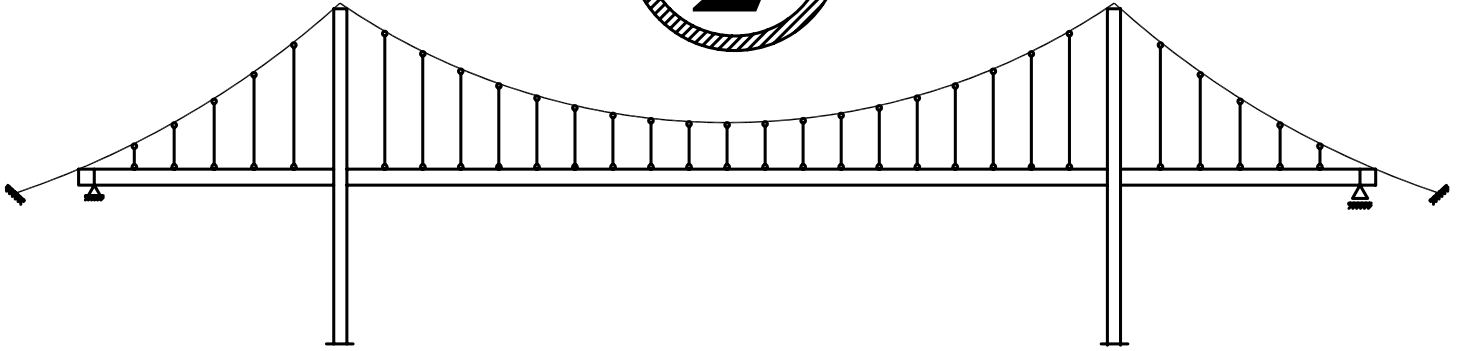


2

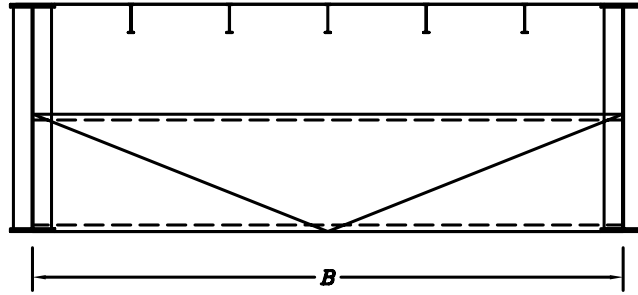


*Lay-Out of  
Plate Girder  
Rail Way  
Bridge*

# Steel Bridges

## Layout of Plate Girder Rail Way Bridge

في حالة ال *Road Way* كوبرى العربات تم استعمال بلاطه خرسانه عليها طبقه من الاسفلت لكي يسير عليها السيارات  
اما في حالة القطارات فلن يتم استعمال البلاطه الخرسانه وسوف يتم استعمال قضبان لكي يسير عليها القطار  
ونلاحظ ان الفرق بين ال *Road Way* , *Rail Way* ان كوبرى ال *Rail Way* تكون القطارات لها مسارات محدده على القضبان بمعنى انها ليست سياره تتحرك في اى نقطه و اى اتجاه على الكوبرى وعلى ذلك يتم وضع *Stringer* تحت كل قضيب لكي تتحمل ال *Stringers* احمال القضبان مباشرة ثم نقلها الى ال *Cross Girder* ثم الى ال *Main Girder* ويعتبر هذا هو اول فرق وهو ان عدد ال *Stringers* ليست معتمده على عرض الكوبرى (*B*)

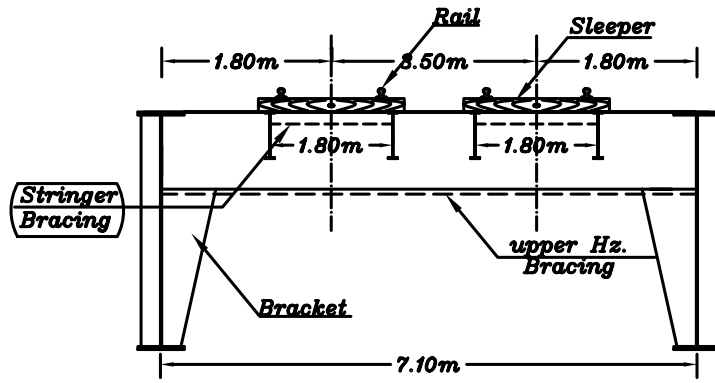


ولكن معتمده على عدد القضبان فكل قضيب تحته *Stringer* وكل قطار (*Track*) له قضيبان (*2 Rails*)

*Single track* —————> *2 Rails* —————> *2 Stringer*

*Double track* —————> *4 Rails* —————> *4 Stringer*

*Triple track* —————> *6 Rails* —————> *6 Stringer*

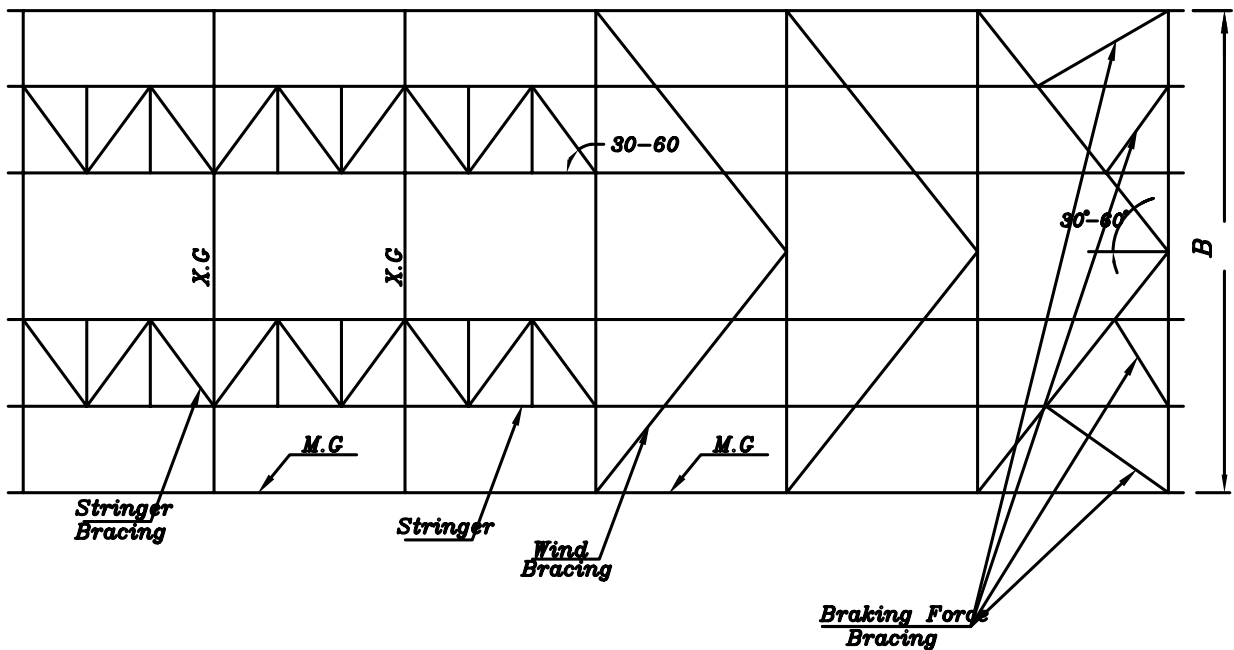


نلاحظ من الرسمه السابقه ان الاختلاف بين الكوبرى ال Rail Way وال Road Way يكون فى ال Stringer Bracing

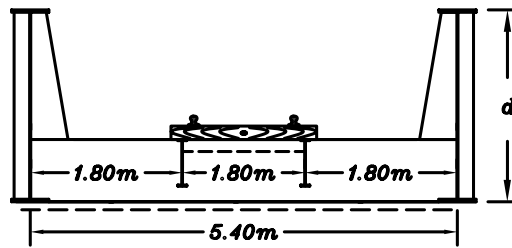
### Stringer Bracing

–there must be a stringer bracing to carry lateral shock and Braking Force Bracing to carry braking force (قوى الفرمله)

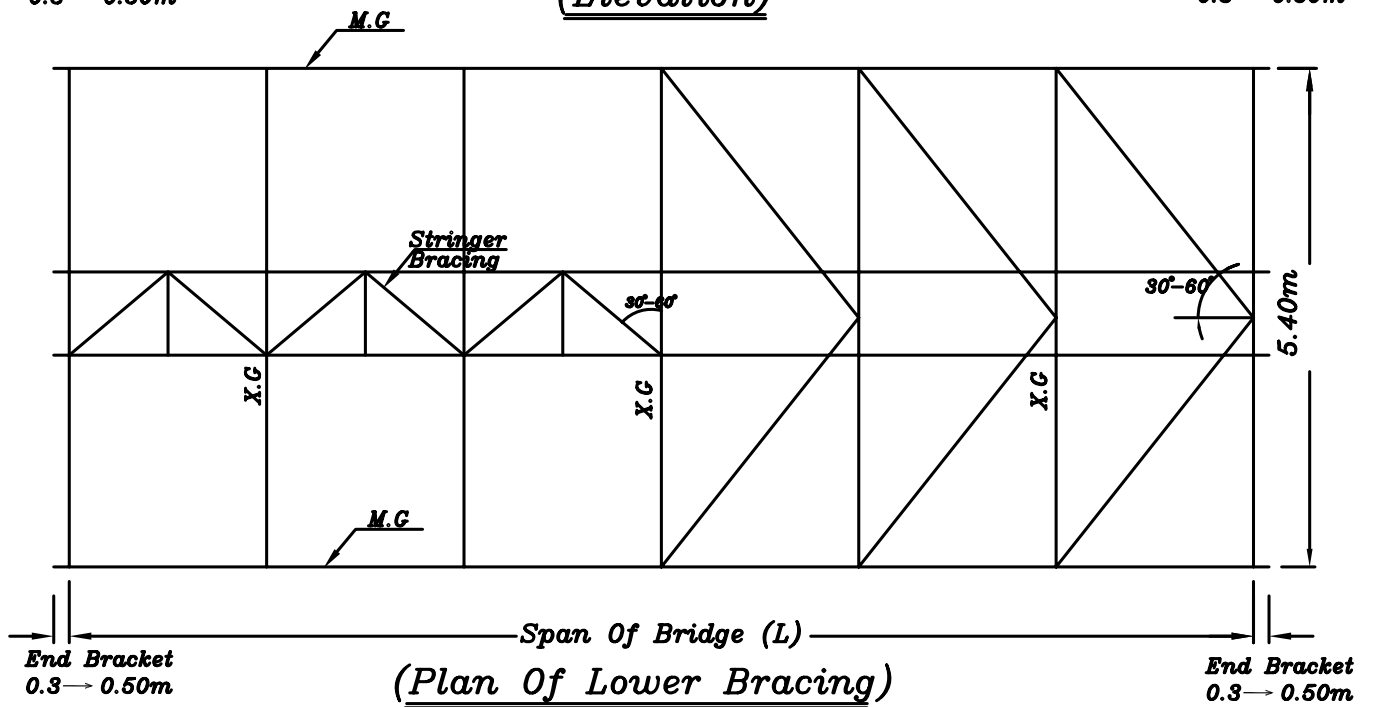
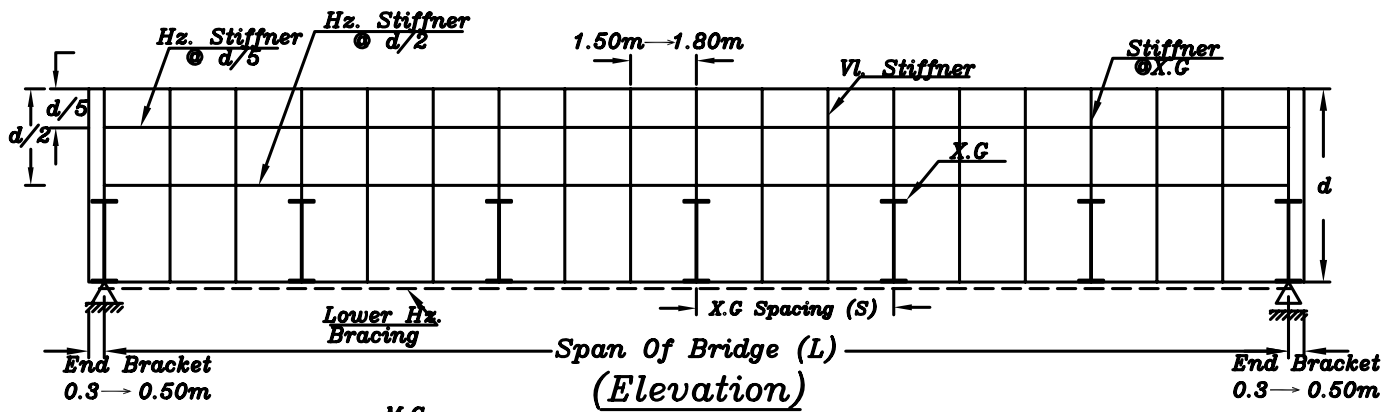
in road way there was no lateral shock and the braking force was carried by slab to main girders to supports , but in case of rail way bridge if there is no braking force bracing there will be  $M_r$  (Out of plane moment) On Cross Girders



(Plan of Floor Beams)



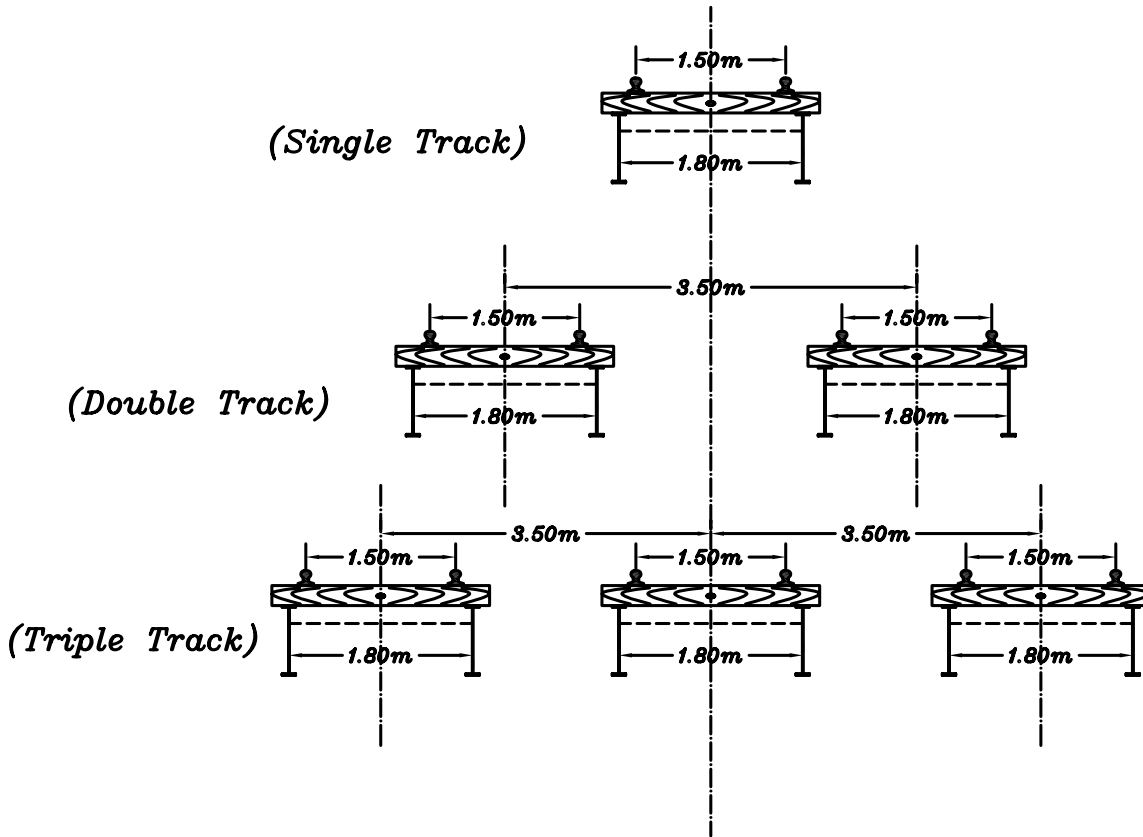
Cross Section



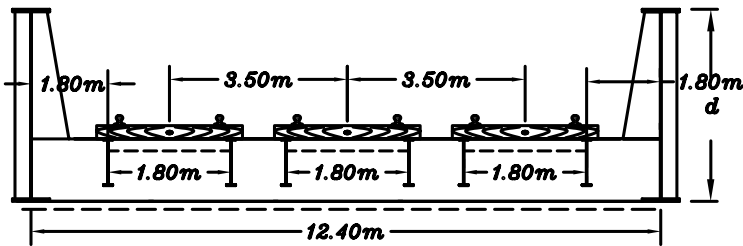
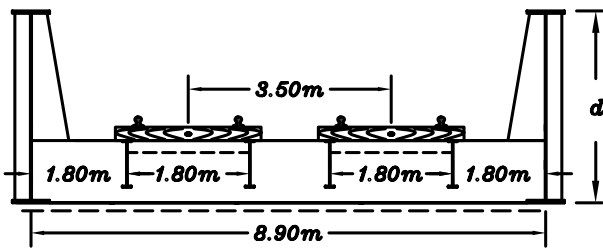
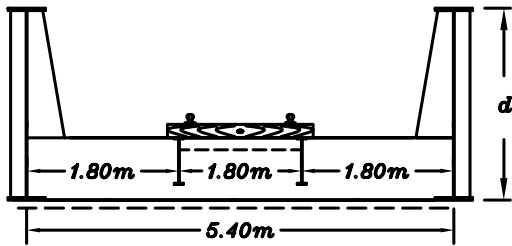
١- فى حالة رسم الكوبرى Rail Way pony bridge يكون هناك 2Plans فقط الاول يوضح Stringer & Stringer Bracing والثانى يوضح Wind Bracing and Braking Force Bracing ومن الممكن رسم ال 2Plans على Plan واحد

٢- فى حالة رسم الكوبرى Rail Way Deck bridge يكون هناك 3Plans فى حالة عدم استعمال Bracket اما عند استعمال Bracket يكون هناك 2Plans فقط

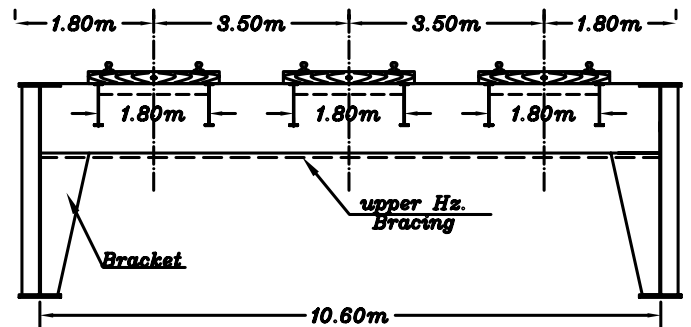
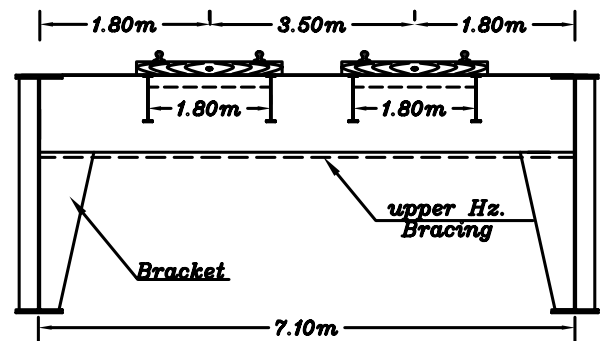
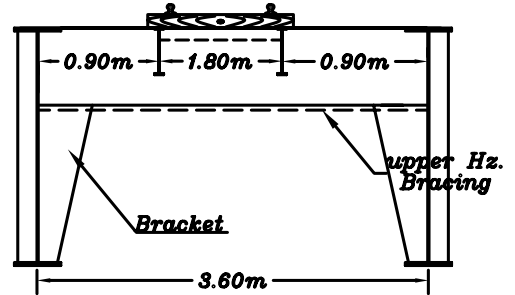
٣- عرض الكوبرى (B) فى حالة ال Rail Way Bridge يكون ثابت تقريبا لان عرض القطار ثابت ونحصل على ابعاد الفلنكات كالتالى



Pony Bridge

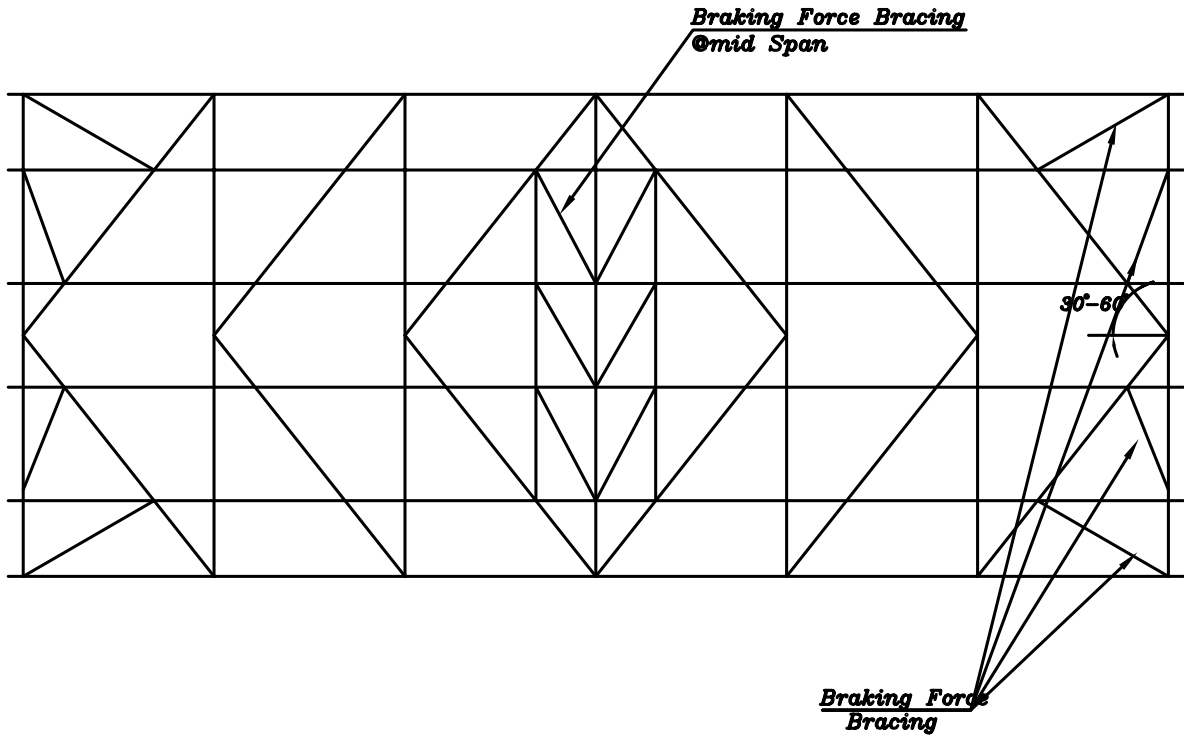


Deck Bridge



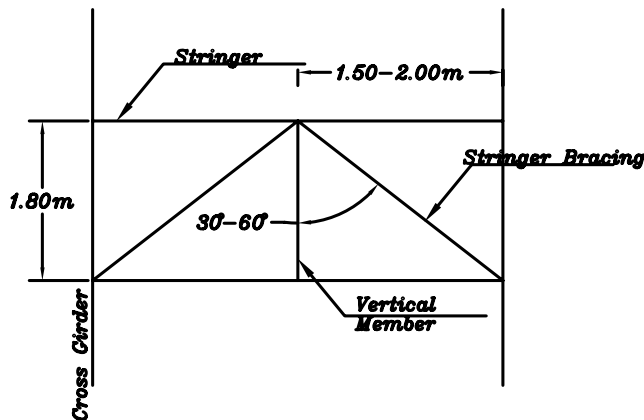
٤- المسافه بين كل اثنين *Srtinger* في *track* واحد ٨,٠م والمسافه بين منتصف *track* ومنتصف *track* آخر ٣,٥ م

5-the braking force bracing is added at both ends and if  
Span > 50.00m , add another bracing @ mid Span



Plan Of Wind and Braking Force Bracing

٦-المسافه بين ال Vertical member لل Stringer Bracing تكون ما بين ١,٥٠م الى ٢,٠٠م وذلك للحفاظ على زاوية ال Stringer Bracing ان تكون ما بين ٣٠-٦٠°

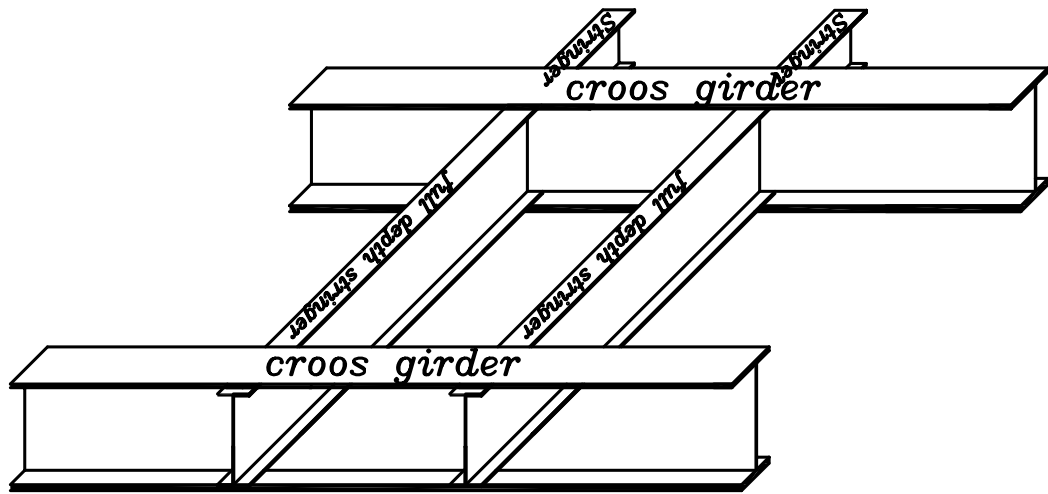


وكلما تغيرت المسافه بين ال Cross Girders كلما تغير شكل ال Bracing للحفاظ على الزاويه ما بين 30°-60°

7—the level of braking force bracing is at the level of the lower flange of cross girder

the braking force is transmitted from the level of rail (Upper flange of cross girder) to level of braking force bracing (Lower flange of cross girder) by one of the following methods

#### A—Full Depth Stringer



at the first and last panel and may be at middle pannel (if span  $> 50.00\text{m}$ ) , the stringer is taken with the same hight as cross girder , then the braking force is transmitted to the level of lower flange of the cross girder to the braking force bracing to the wind bracing to the bearing

ملحوظه

يتم رسم ال Braking Force Bracing على الرسمه فى المساله فى حالة طلب ذلك فقط

وتعتبر ال Full depth stringer هى اكثر طريقه مستخدمه لنقل ال Braking Force بها



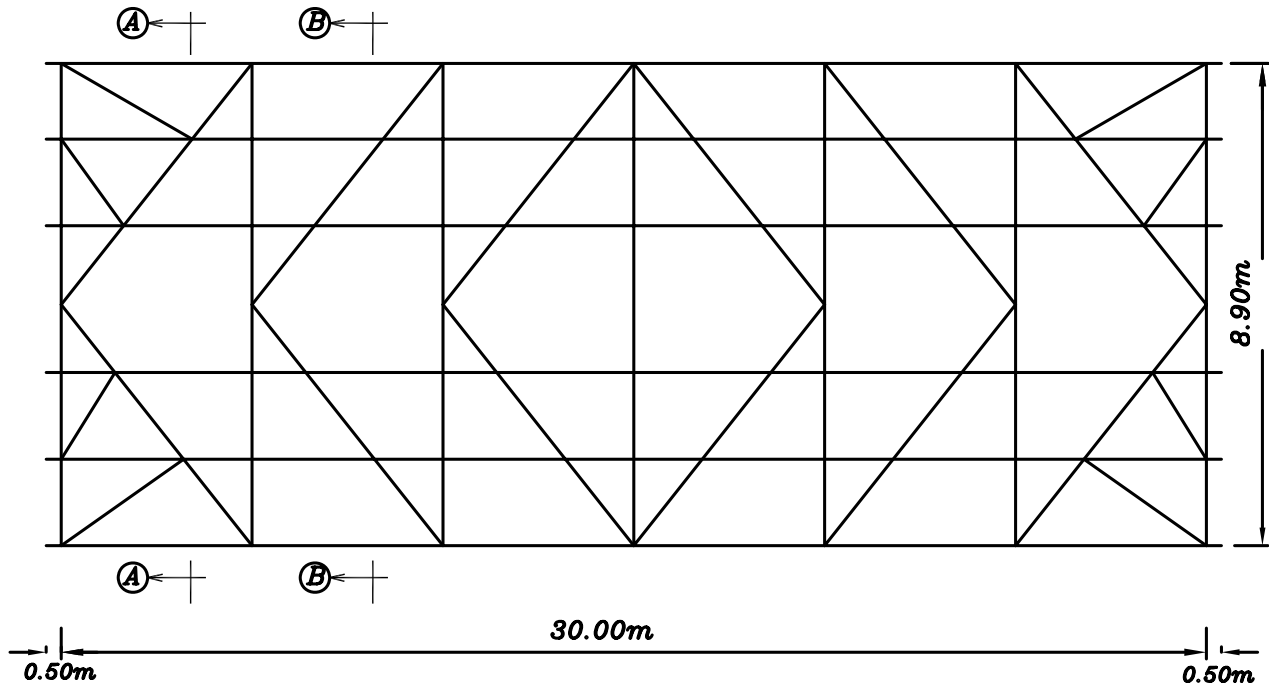
## Example(1)

نظري فقط

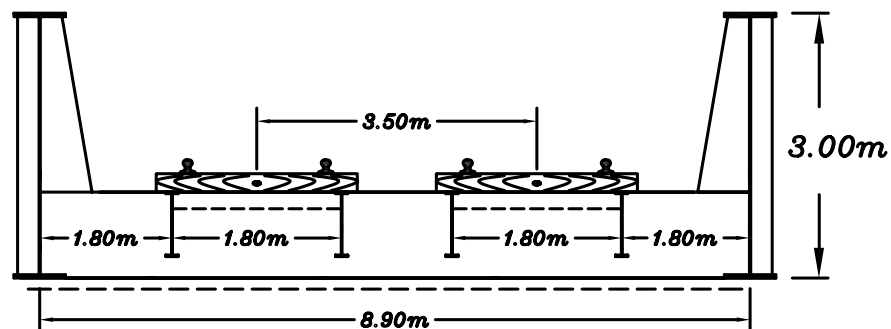
For Pony , Double track Rail Way it is required to Draw

a-Plan of wind and braking force bracing

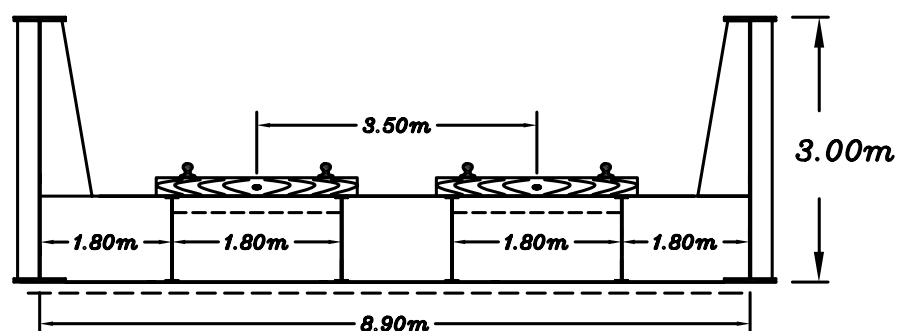
b-2 diffrent cross sections showing how the braking force is transmitted  $L = 30.00m$



(Plan Of Lower Bracing)



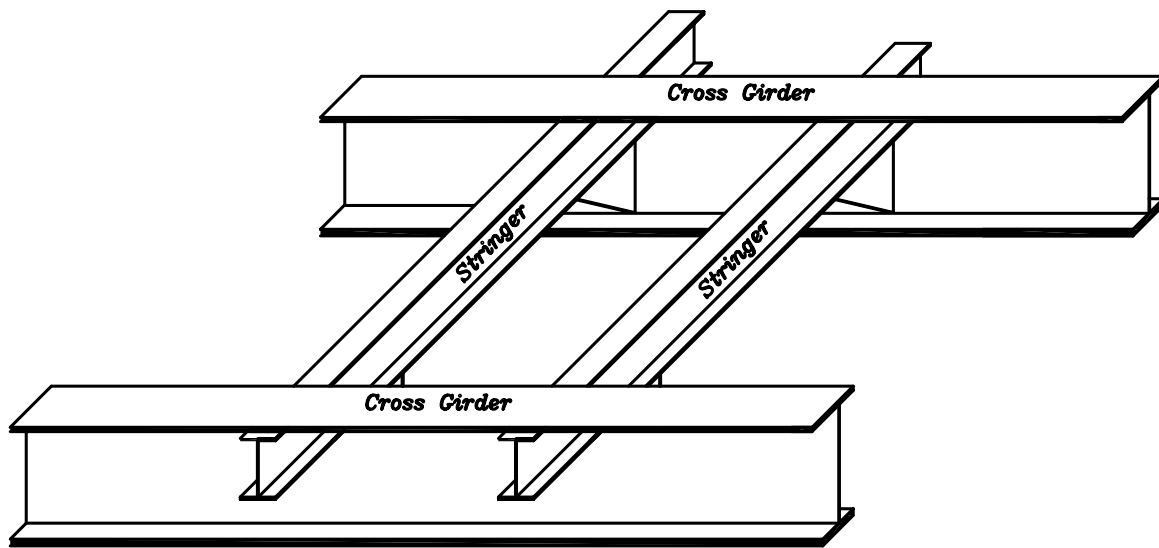
Section(B-B) @ Intermediate Pannels



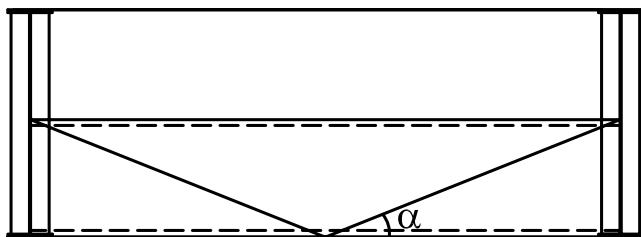
Section(A-A) @ Both ends

## B-inverted U-Frame

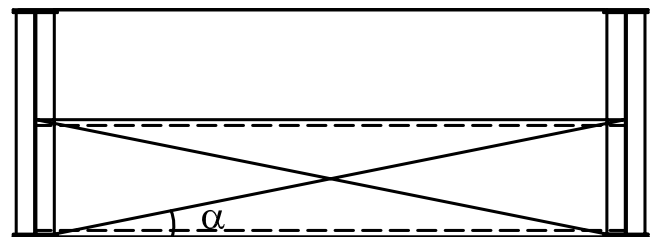
*inverted u-frame at the places of beraking force bracing*



*8-the cross frame is either X-system or V-system according to the angle from  $30^\circ$  to  $60^\circ$*

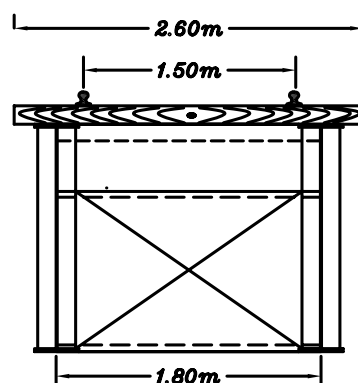


V-System

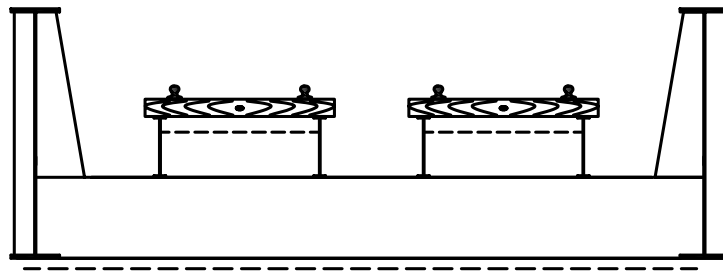


X-System

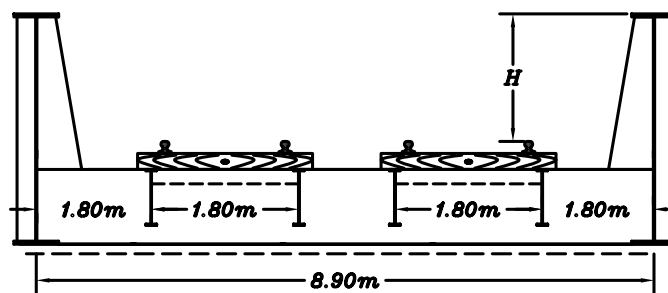
*9-in case of single track deck bridges , the bridge may compose of 2 main girders and cross girder without stringers (the main girders are used at the position of stringers)*



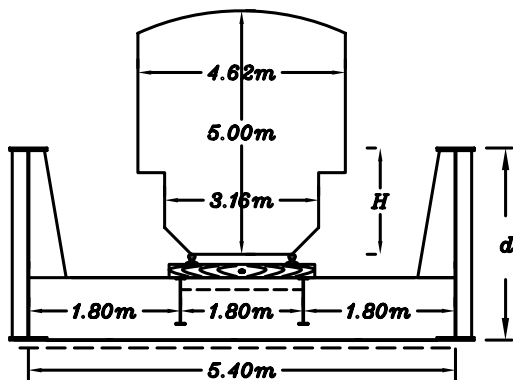
10- the stringer may be added Over the cross girder



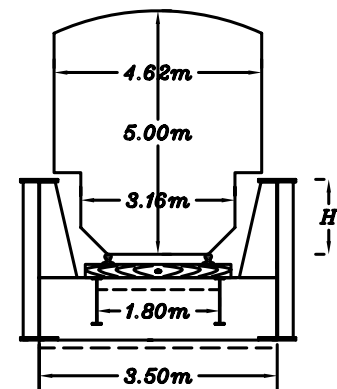
١١- يمكن تقليل عرض الكوبرى فى حالة الكوبرى ال *Semi Deck* او الكوبرى ال *Pony* ويعتمد تقليل عرض الكوبرى على الارتفاع  $H$



Where  $H$  : the distance from the top of the rail to the top of Main Girder

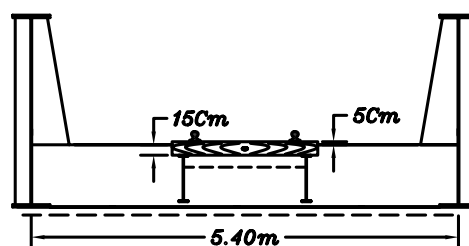


$$H > 0.95$$

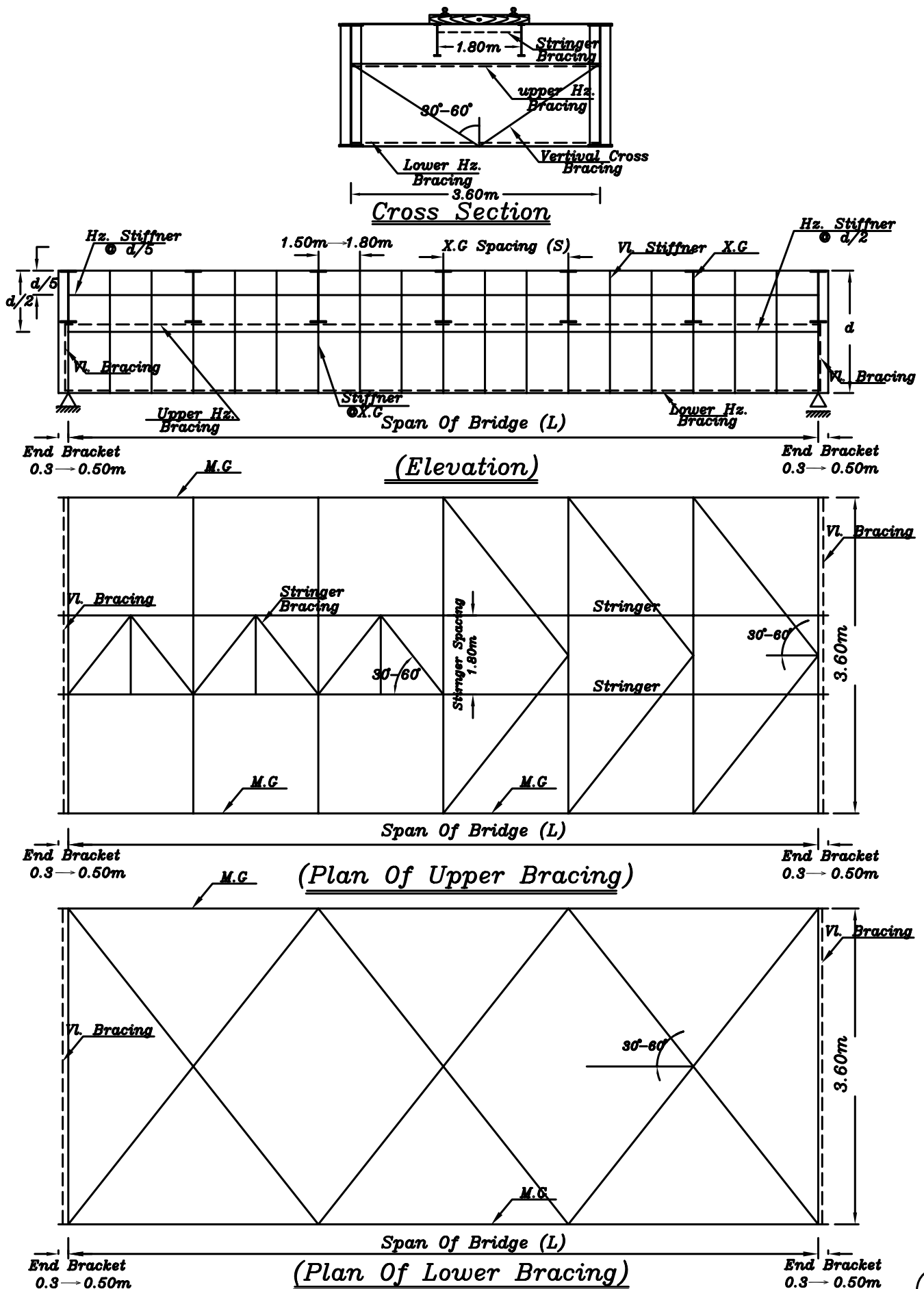


$$H < 0.95$$

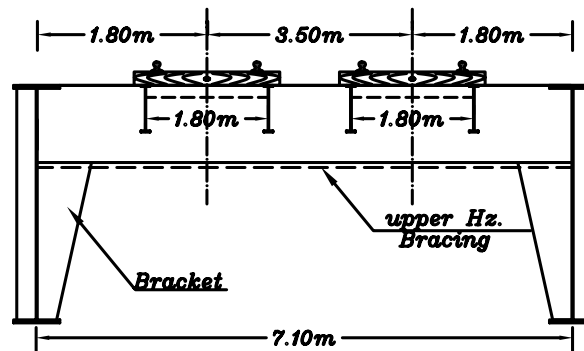
١٢- من الممكن ان يتم تغطيس ال *Sleeper* داخل ال *Cross Girder* بمقدار 15Cm



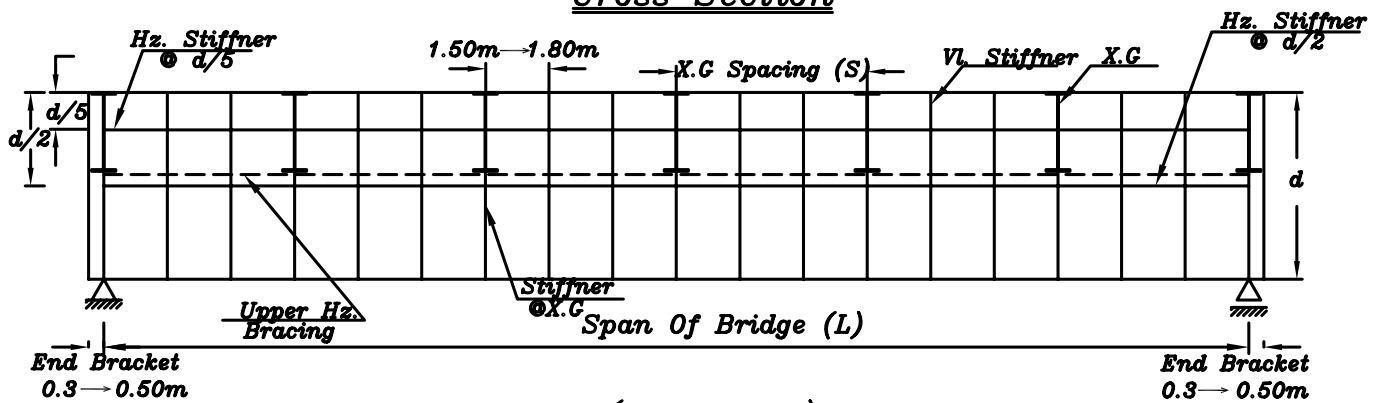
# PLATE GIRDER DECK BRIDGE RAIL WAY WITH VERTICAL BRACING (SINGLE TRACK)



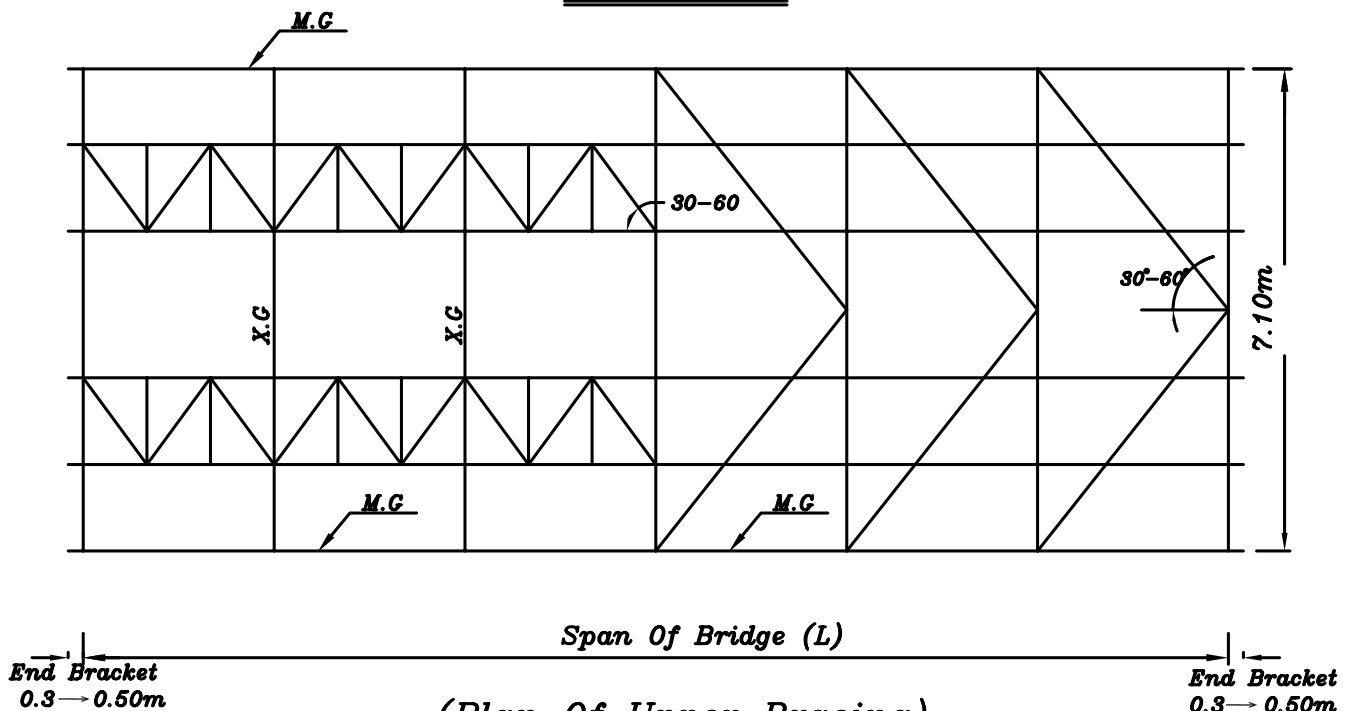
# PLATE GIRDER DECK BRIDGE RAIL WAY WITH INVERTED U-FRAME (DOUBLE TRACK)



Cross Section

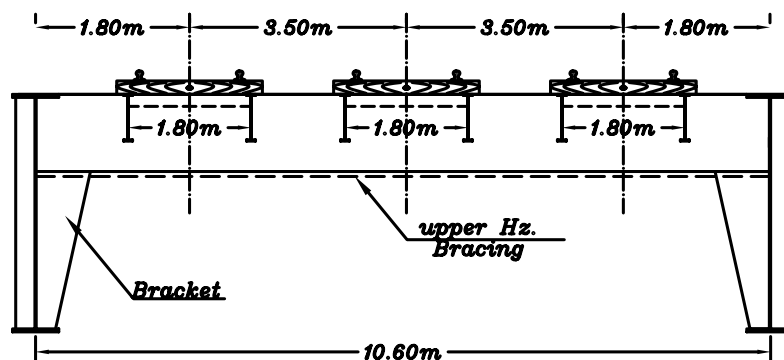


(Elevation)

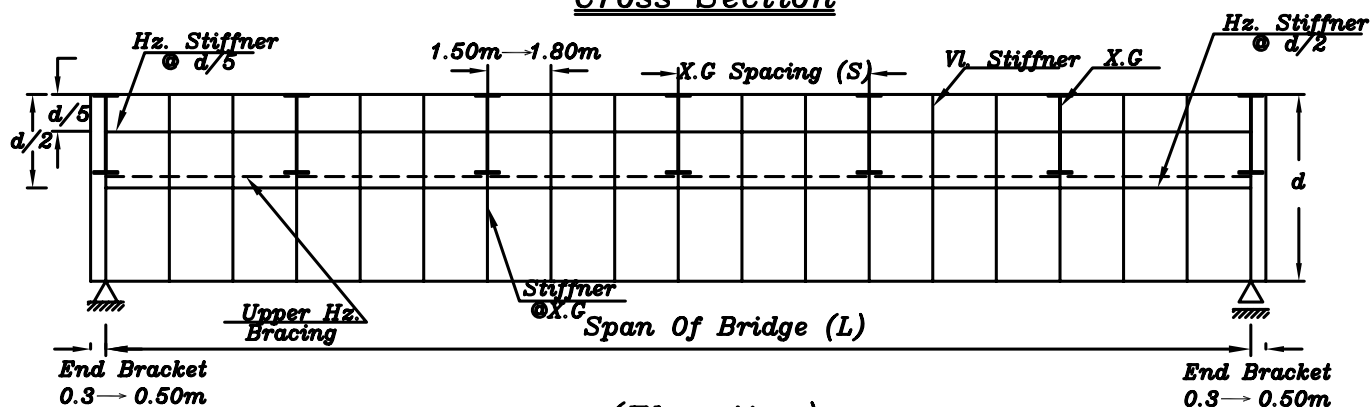


(Plan Of Upper Bracing)

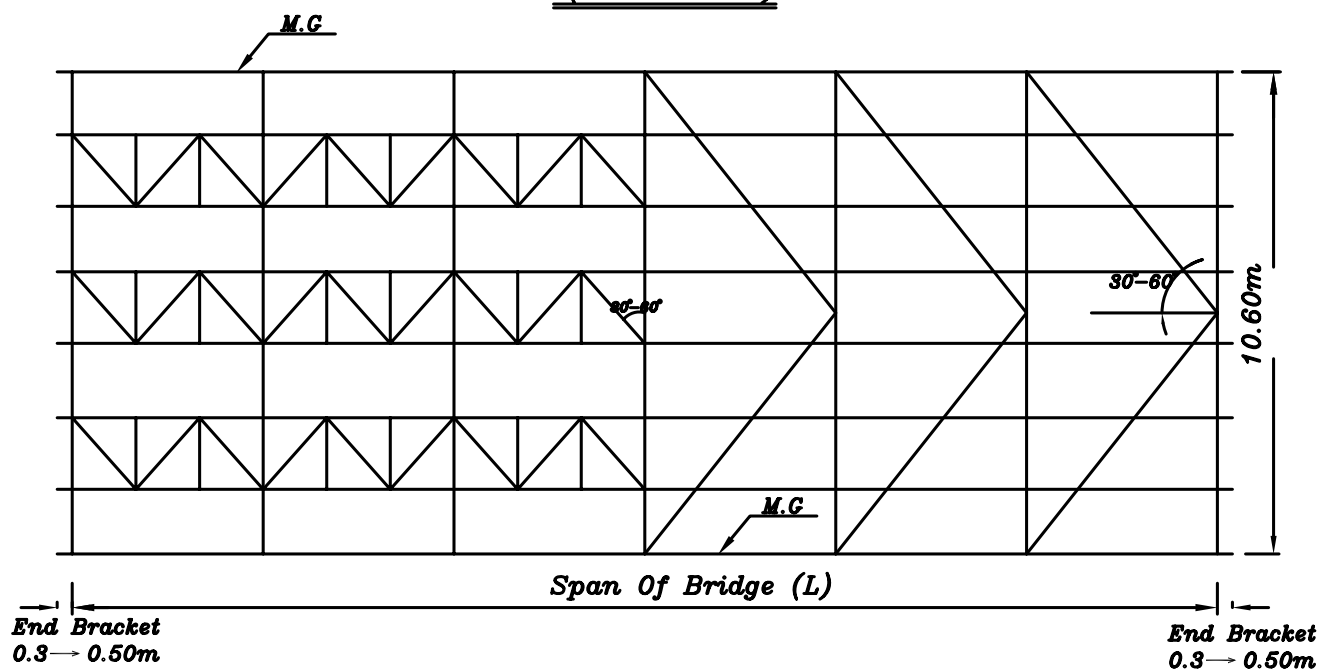
# PLATE GIRDER DECK BRIDGE RAIL WAY WITH INVERTED U-FRAME. (TRIPLE TRACK)



Cross Section

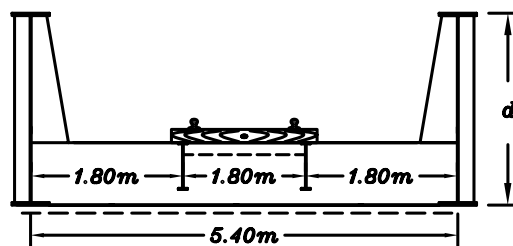


(Elevation)

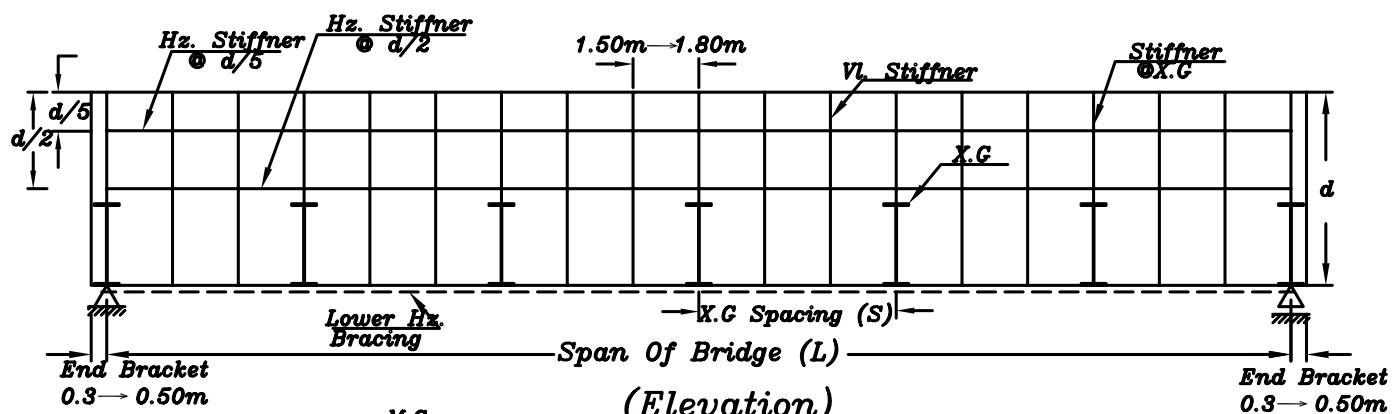


(Plan Of Upper Bracing)

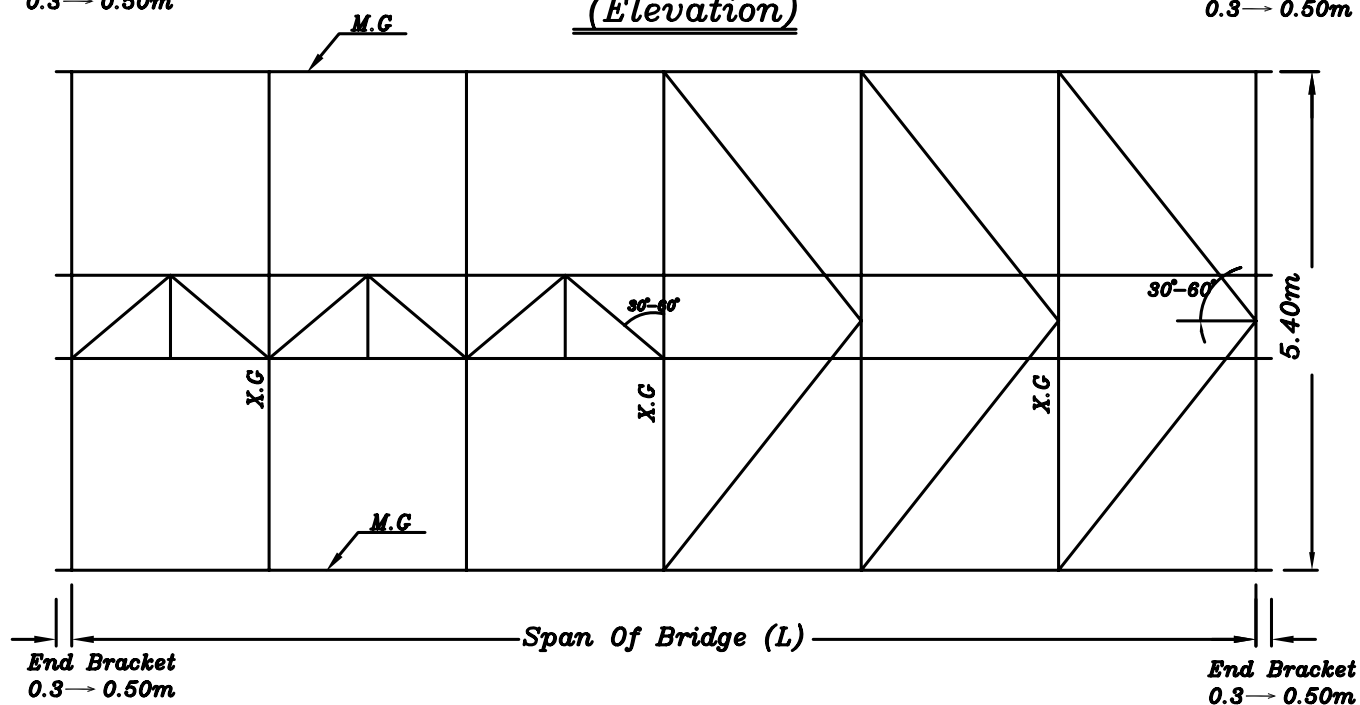
# PLATE GIRDER PONY BRIDGE RAIL WAY SINGLE TRACK



Cross Section

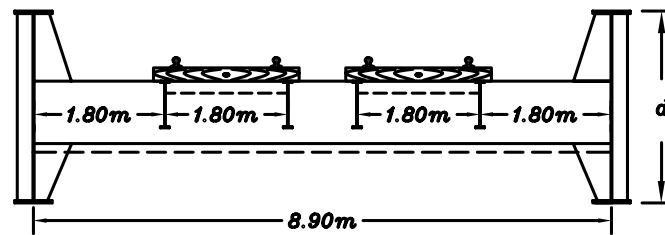


(Elevation)

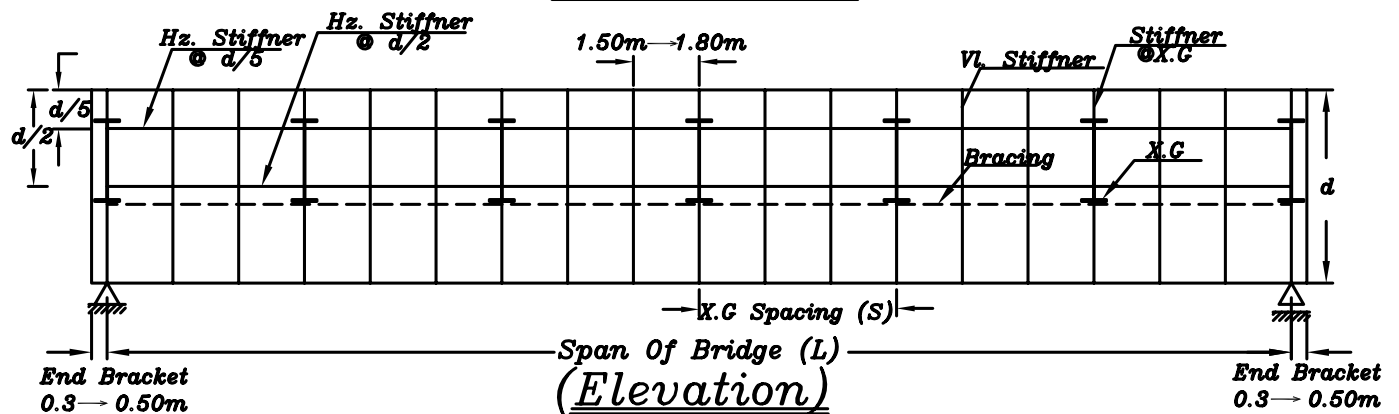


(Plan Of Lower Bracing)

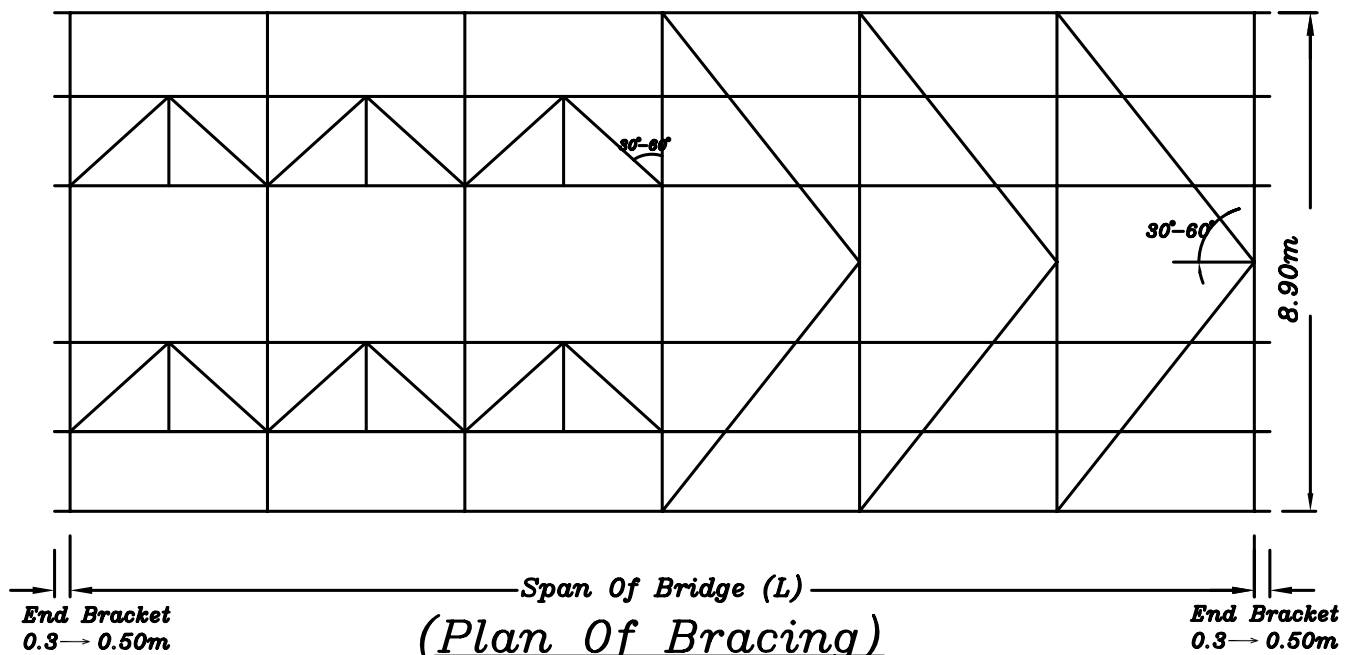
# PLATE GIRDER SEMI-DECK BRIDGE RAIL WAY WITH U-FRAME (DOUBLE TRACK)



Cross Section



(Elevation)



(Plan Of Bracing)



# How To Determine the Type Of The Bridge Whether It Is Deck , Pony

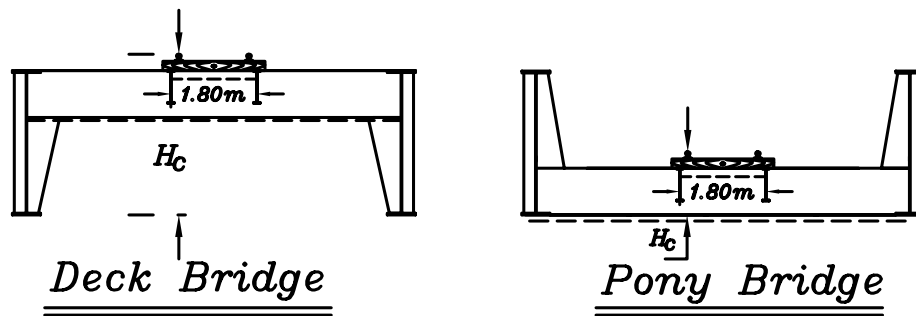
يعتمد اختيار نوع الكوبرى على اساس تثبيت الـ Compression Flange و هي الـ Upper Flange For M.G وذلك لكي يكون الكوبرى اقتصادى و على هذا يعتبر افضل اختيار هو اختيار الـ Deck Bridge لان الـ X.G تعمل على تثبيت الـ Upper Comp. Flange For M.G ثم يفضل بعد هذا الـ Semi-Deck ثم الـ Pony Bridge

## وثانى اساس يعتمد عليه اختيار نوع الكوبرى هو

1) available Height Of Construction "H"

2) Construction height of the Bridge " $H_c$ "

$H_c$  :- is measured from the top of the bridge floor (the rail level) to the level of the bottom flange of plate girder



## Construction Height Of The Bridge " $H_c$ "

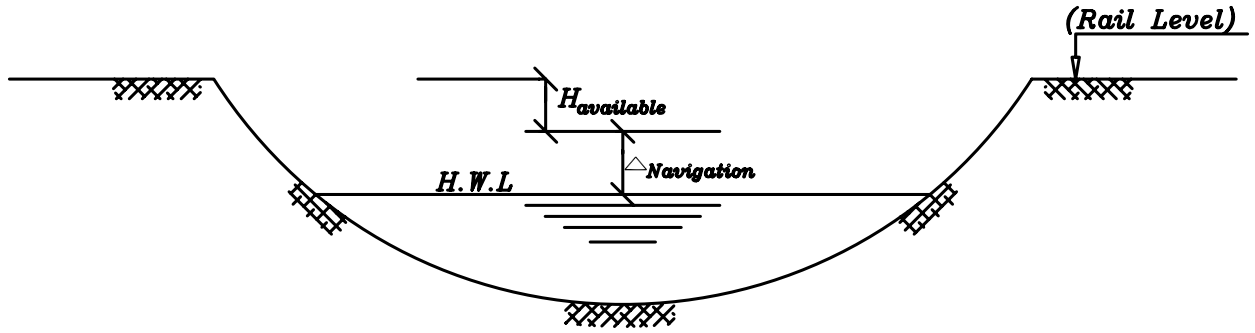
### Road Way

### Height Of Construction For Deck Bridge

$$H_{deck} = \frac{\text{Span } (L)}{(8 \rightarrow 12)} + 0.03 + 0.03 + 0.15 + 0.2 + \frac{L}{800} + 0.02$$

upper & lower flange thickness ——— 0.03  
 Rail ——— 0.03  
 Sleeper ——— 0.15  
 deflection ——— 0.2  
 safety ——— 0.02

## Available Height Of Construction



$$H_{available} = \text{Rail Level} - H.W.L - \triangle Navigation$$

$\triangle Navigation(\text{Given})$  ,  $\text{Rail Level}(\text{Given})$  ,  $H.W.L(\text{Given})$

$H_{available} ??$

وعلى هذا يجب ان يكون  $H_{Construction}$  اقل من او يساوى  $H_{available}$

If  $H_{deck} \leq H_{available}$  ,° Use Deck Bridge

If  $H_{deck} \geq H_{available}$  ,° Use Pony or semi-deck

° من القوانين السابقة نستنتج انه اذا كان ارتفاع الكوبرى ال  $deck$  اقل من الارتفاع المسموح (معطى فى المساله) يتم استعمال  $Deck Bridge$  اما اذا كان اكبر يتم استعمال  $Pony$

### Example(1)

*Rail Way Single track Plate Girder Bridge Having a Span of 28.00m and available height of construction 3.40m*

### Solution

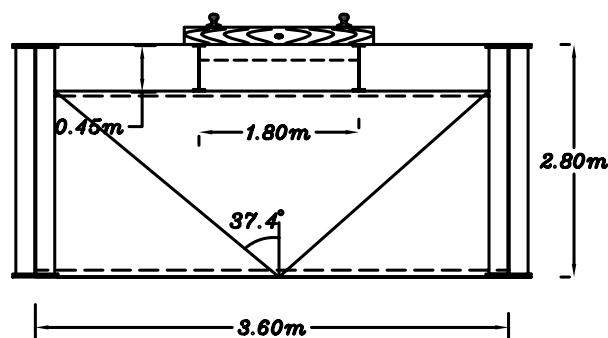
Height Of construction =		
web of M.G. = $L/10$	=	280cm
+ two flanges of M.G. = $2*3$	=	6cm
+ sleepers height	=	20cm
+ rail height	=	15cm
+ deflection of M.G. = $L/800$	=	3.5cm
+ safety	=	2cm
		<hr/>
		326.5cm

$$\text{Height Of construction} = 3.265\text{m}$$

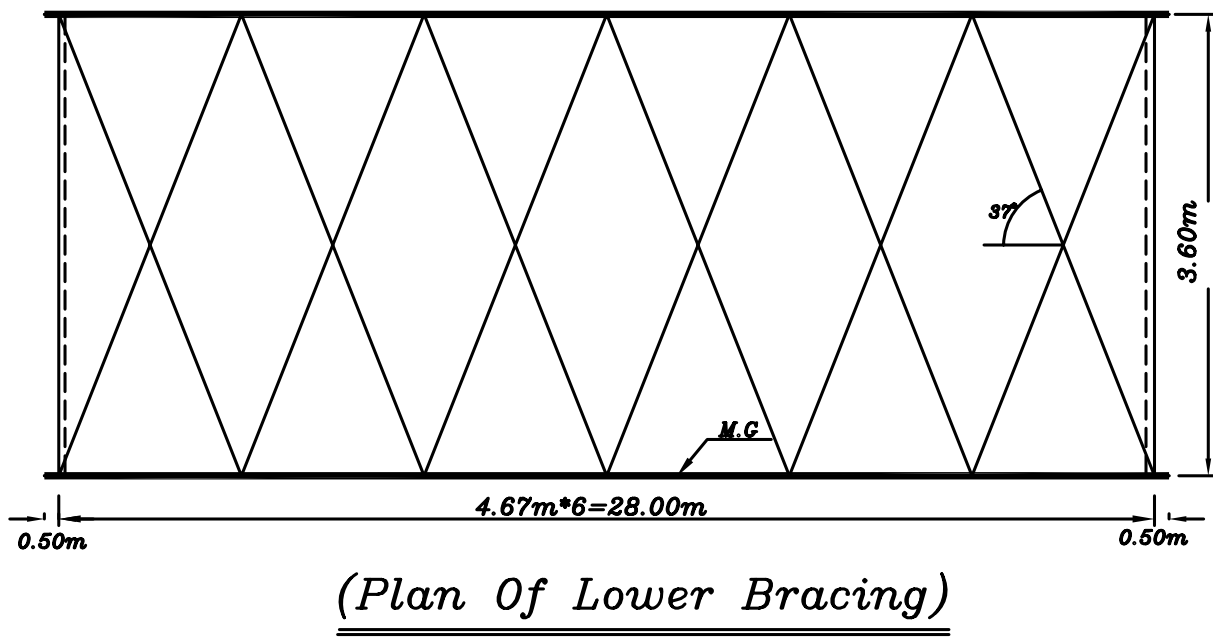
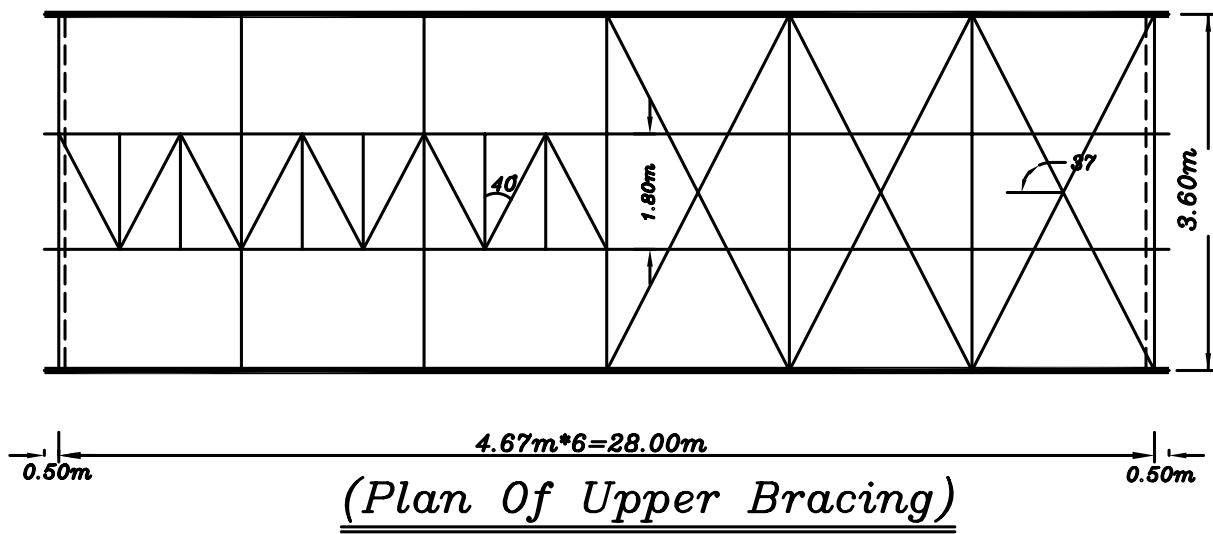
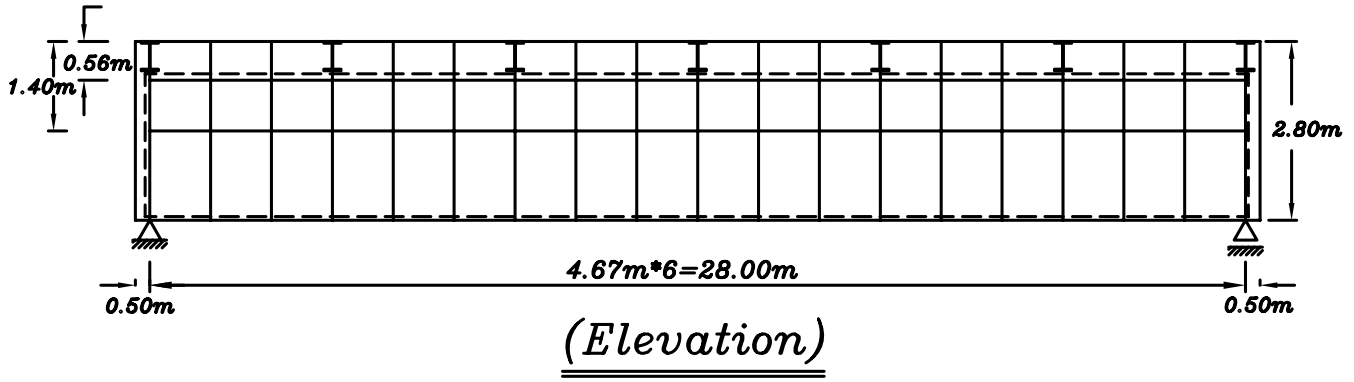
$$3.265\text{m} < 3.40\text{m}$$

∴ Use Deck Bridge

try to Use X-Bracing Or V-Bracing First



∴ Use Deck Bridge With V Bracing



## Example(2)

Rail Way triple track Plate Girder Bridge Having a Span of 26.00m and available height of construction 2.85m

---

## Solution

$$\begin{aligned} \text{Height Of construction} = & \\ & \text{web of M.G.} = L/10 = 260\text{cm} \\ & + \text{two flanges of M.G.} = 2*3 = 6\text{cm} \\ & + \text{sleepers height} = 20\text{cm} \\ & + \text{rail height} = 15\text{cm} \\ & + \text{deflection of M.G.} = L/800 = 3.2\text{cm} \\ & + \text{safety} = 2\text{cm} \\ & \hline & 306.2\text{cm} \end{aligned}$$

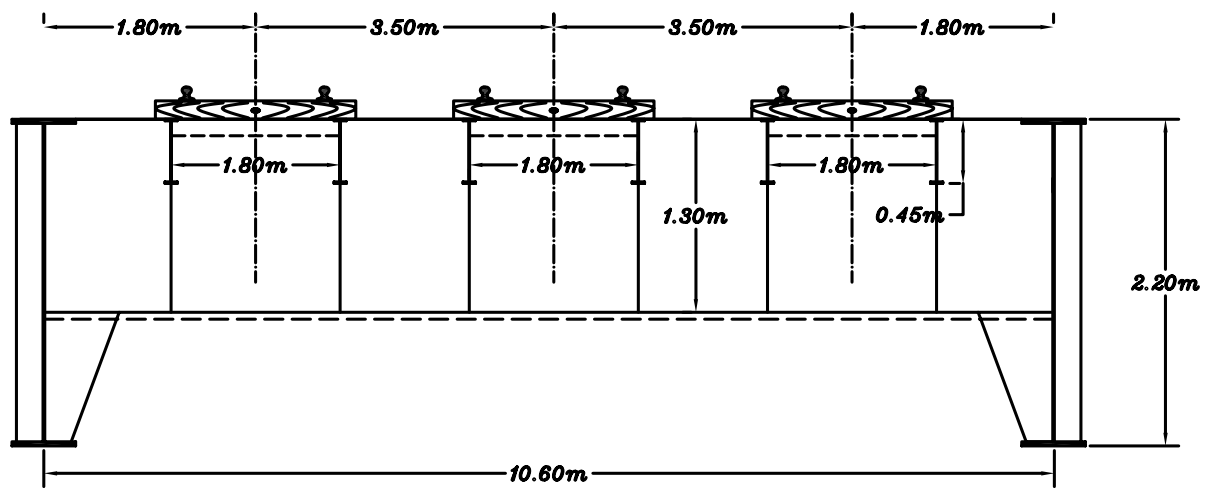
$$\text{Height Of construction} = 3.062\text{m}$$

$$3.05\text{m} > 2.85\text{m}$$

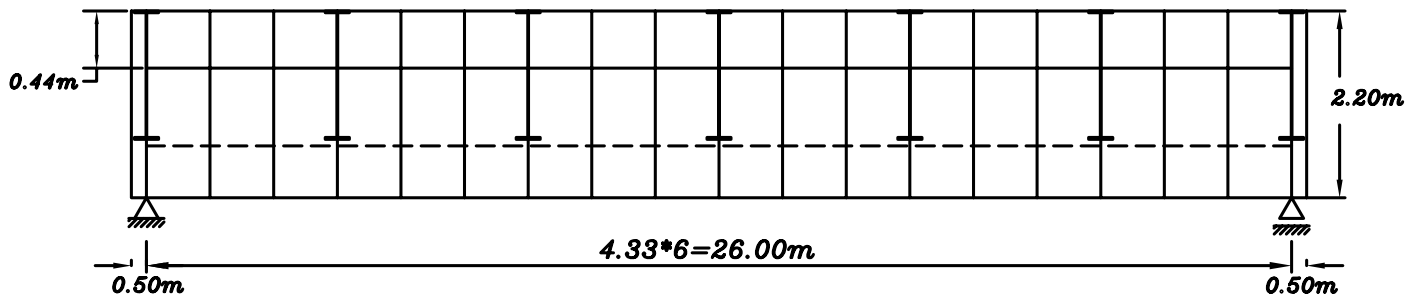
$$\begin{aligned} \text{try another height Of construction} = & \\ & \text{web of M.G.} = L/12 \cong 220\text{cm} \\ & + \text{two flanges of M.G.} = 2*3 = 6\text{cm} \\ & + \text{sleepers height} = 20\text{cm} \\ & + \text{rail height} = 15\text{cm} \\ & + \text{deflection of M.G.} = L/800 = 3.2\text{cm} \\ & + \text{safety} = 2\text{cm} \\ & \hline & 266.2\text{cm} \end{aligned}$$

$$2.66\text{m} < 2.85\text{m}$$

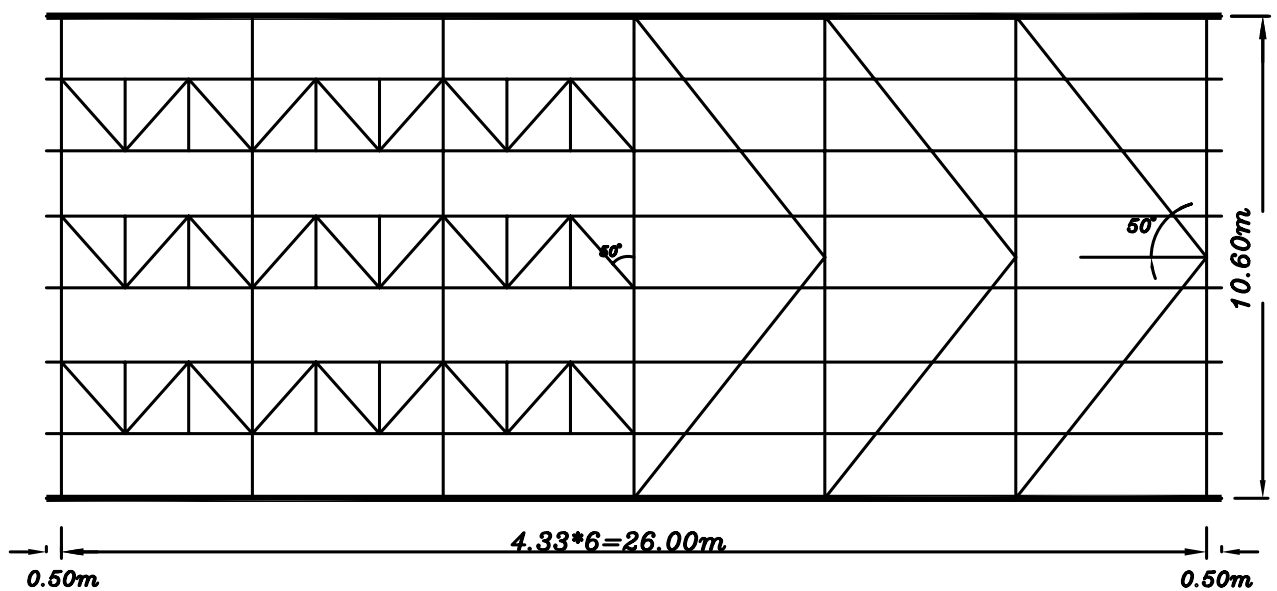
$$\therefore \text{Use Deck Bridge with Plate girder depth} = 2.20\text{m}$$



(Cross Section)



(Elevation)



(Plan Of Upper Bracing)

### Example(3)

Rail Way Double track Plate Girder Bridge Having a Span of 30.00m and available height of construction 1.75m

### Solution

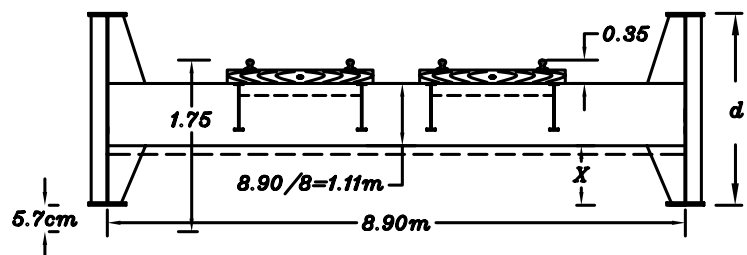
Height Of construction =		
web of M.G. = $L/10$	=	300cm
+ two flanges of M.G. = $2*3$	=	6cm
+ sleepers height	=	20cm
+ rail height	=	15cm
+ deflection of M.G. = $L/800$	=	3.7cm
+ safety	=	2cm
		<hr/>
		346.7cm

$$\text{Height Of construction} = 3.467\text{m}$$

$$3.467\text{m} > 1.75\text{m}$$

∴ Deck Bridge Not Allowed

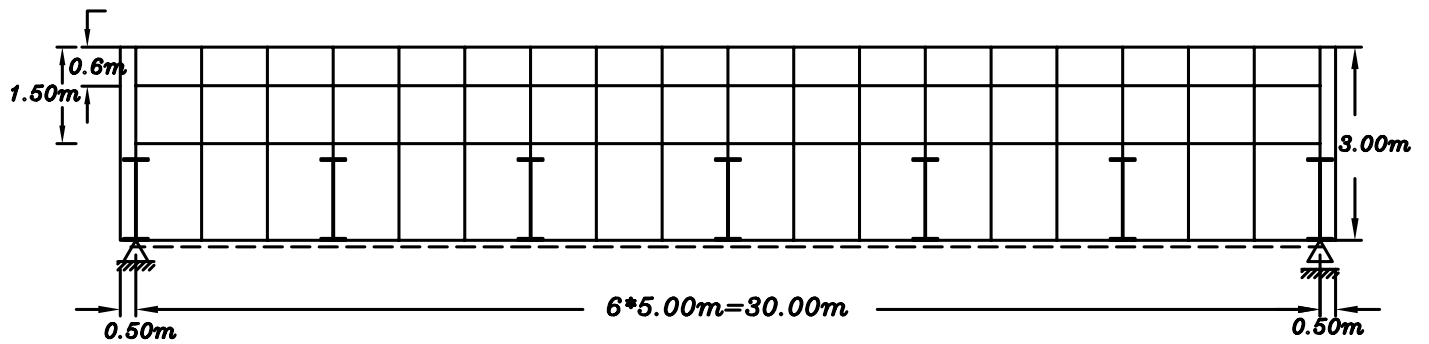
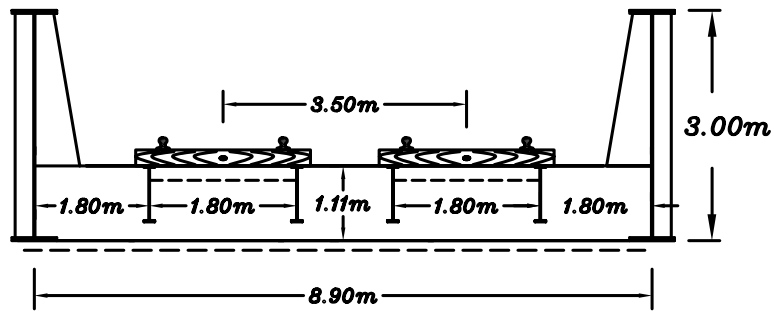
try semi Deck Bridge



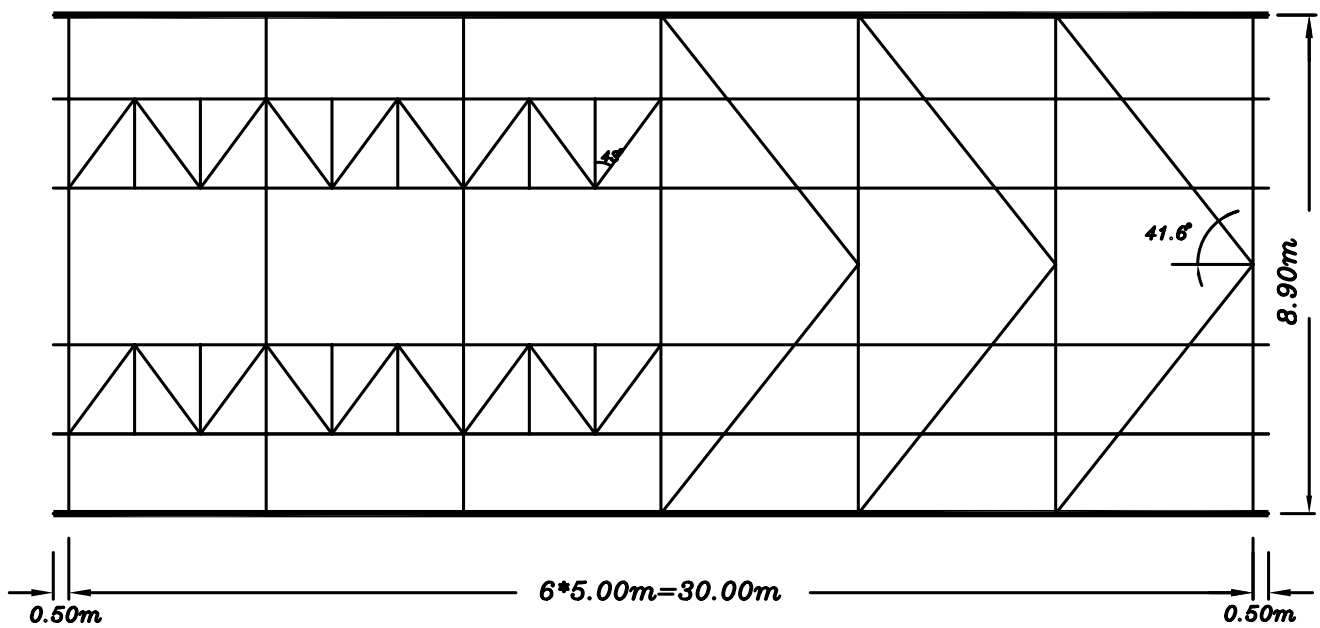
$$X = 1.75\text{m} - 0.35\text{m} - 1.11\text{m} - 0.057 = 0.24\text{m} < 0.50\text{m}$$

∴ Semi-Deck Bridge is not allowed

∴ Use Pony Bridge



(Elevation)



(Plan Of Bracing)



### Example(4)

*Rail Way Double track Plate Girder Bridge Having a Span of 26.00m and available height of construction 2.40m  
it is required to*

*1-Draw General Lay out of the Bridge*

*2-show how the braking force be transmute*

*3-show in sketch the effect of removal Braking force bracing*

### Solution

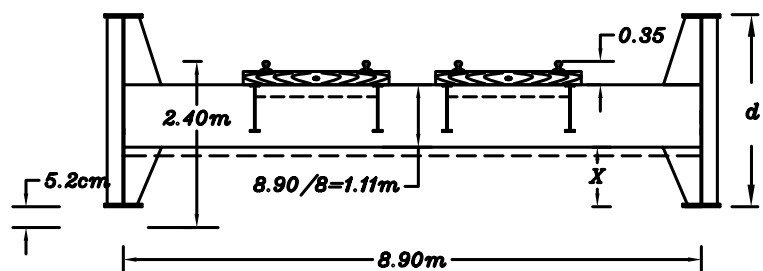
*Height Of construction =*

<i>web of M.G. = <math>L/10</math></i>	<i>=</i>	<i>260cm</i>
<i>+ two flanges of M.G. = <math>2*3</math></i>	<i>=</i>	<i>6cm</i>
<i>+ sleepers height</i>	<i>=</i>	<i>20cm</i>
<i>+ rail height</i>	<i>=</i>	<i>15cm</i>
<i>+ deflection of M.G. = <math>L/800</math></i>	<i>=</i>	<i>3.2cm</i>
<i>+ safety</i>	<i>=</i>	<i>2cm</i>
		<b>306.2cm</b>

*3.062m > 2.40m*

*∴ Deck Bridge is not allowed*

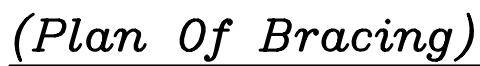
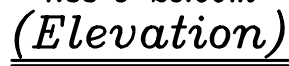
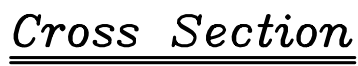
*try semi Deck Bridge*



*$2.40m - 0.35m - 1.11m - 0.052 = 0.89m > 0.50m$*

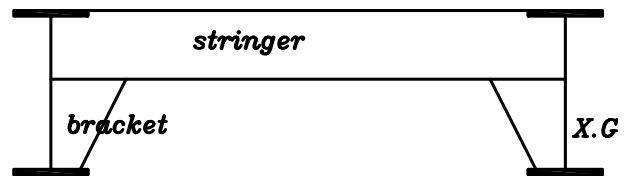
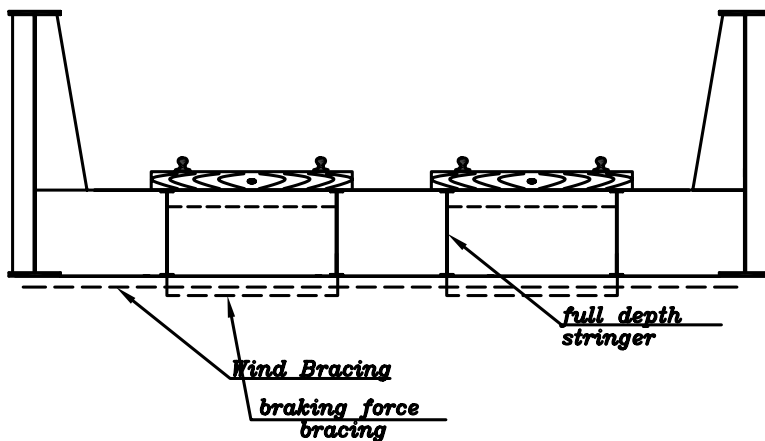
*∴ the bridge is able to be semi-deck*

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## Question2

to trasmitte the braking force , by using braking force bracing  
is at the lower level of the flange of cross girder  
and to transmitte this force we use either full depth stringer  
at the first and last pannels  
or using inverted u-frames at the place of braking force  
bracing

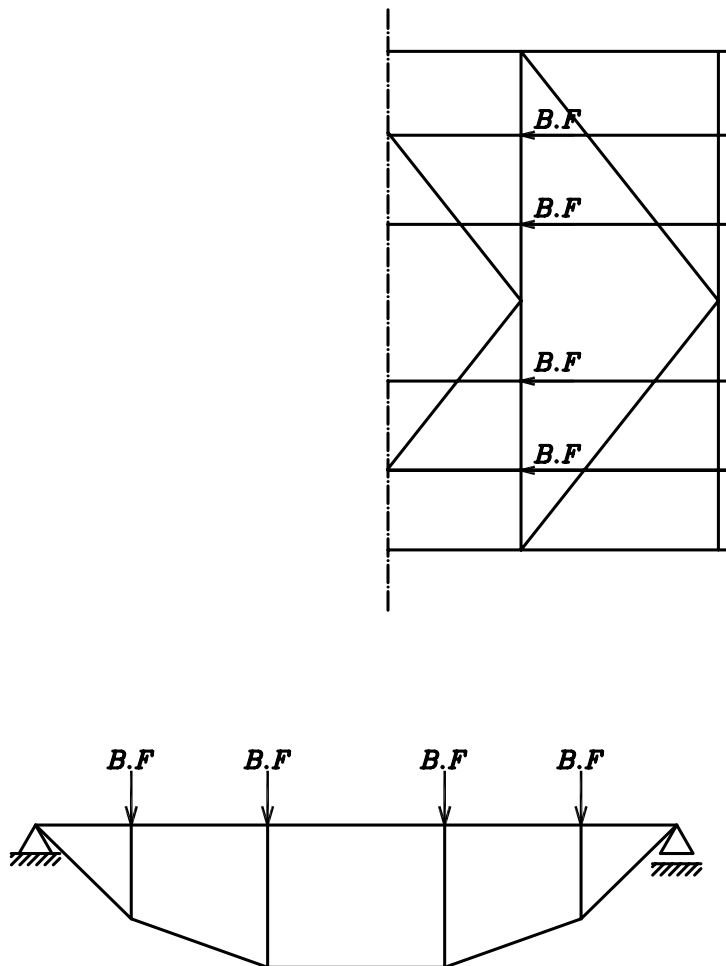


### Question3

if there is no braking force bracing the braking force would not transmitt to the bearing

and it will effect cross girder as shown below

Braking Force( $B.F$ )



the braking force cause  $M_y$  on cross girder

### Example(5) [Mid term 2008]

it is required to construct an open-timber floor double track rail way plate girder bridge with theoretical span of 36.00m and available height of construction of 1.65m . Depth of the cross girder is taken as 1.30ms. Braking forces will be resisted by the cross girders.

–Using a reasonable scale , draw a general layout ( plan , elevation & Cross Section) of the bridge showing the main structural elements , stiffeners and all bracing systems

### Given

–Double track rail way bridge

– $L = 36.00m$   $H_a = 1.65m$  ,  $d_{x.g} = 1.30 ms$

Height Of construction =

web of M.G. = $L/10$	=	360cm
+ two flanges of M.G. = $2*3$	=	6cm
+ sleepers height	=	20cm
+ rail height	=	15cm
+ deflection of M.G. = $L/800$	=	4.5cm
+ safety	=	2cm
		<hr/>
		407.5cm

Height Of construction = 4.075m

$4.075m > 1.65m$

Deck Bridge Not Allowed

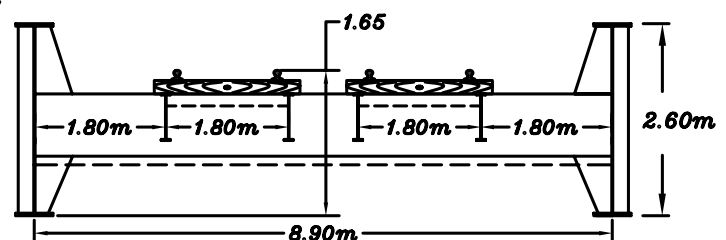
try semi Deck Bridge

$1.65m - 0.45m - 1.30m = -Ve < 0.50m$

∴ Semi-Deck Bridge is not allowed

Try Pony Bridge

$H_{Pony} = d_{x.g} + 0.45 = 1.30 + 0.45 = 1.75 > 1.65m$



نلاحظ وجود مشكله فى هذه المساله وهى ان ال  $H_c$  للكوبرى ال *Pony* اكبر من ال  $H_a$  وهذا يعنى ان الكوبرى ال *Pony* سوف يكون عائق للملاحه فى حالة اذا لم يكن ارتفاع ال *Cross Girder* مُعطى كان من الممكن تقليلها عن  $1.30m$  ولكن هو اعطاها فى الامتحان لكى يتم تقليل ارتفاع آخر غير ارتفاع ال  $X.G$  وهو ارتفاع ال *Rail Or Sleeper* وعلى هذا سوف يتم ادخال ال *Sleeper* داخل ال *Cross Girder* مسافه قدرها  $10Cm$  لكى نحافظ على ان يكون  $H_a = H_c$  لكى يتم عمل الكوبرى

*Pony*

خلى بالك

اكبر مسافه يدخلها ال *Sleeper* داخل ال  $X.G$  هى  $15Cm$

